distribution within said process chamber and th heat flux necessary to complete the process being conducted therein.

REMARKS

The foregoing amendments to claims 1 and 18 are made to more clearly define the present invention and to distinguish claims from the art of record. As pointed out during the interview and in our previous response, the endothermic reaction apparatus in Ruhl does not produce "distributed" combustion in that the perforations in feed gas tube 60 in Fig. 4 of Ruhl are only spaced in burner zone 68. Claims 1 and 18 in the present application have been amended to provide that the plurality of fuel nozzles in Applicant's FDC process heater are spaced <u>substantially</u> along the <u>entire</u> length of the oxidation chamber. Support for this amendment is found inter alia in Figs. 1 and 8 of the present application which show nozzles 6 to be distributed substantially along the entire length of oxidation chamber 1. Since, Ruhl clearly does not anticipate these claims as amended, the rejection of the claims under 35 USC § 102 based on Ruhl should be withdrawn.

Claims 1 and 18 have also been amended to recite that the claimed process heater is for "high temperature reactions" and that the heat flux provided to the process chamber be at "a sufficiently high rate to complete the process being conducted therein". Support for these amendments is found on page 1 of the specification, lines 7-8, page 4, lines 23-27 and page 5, lines 1-2 and 10-11.

The foregoing amendments were made to further distinguish the present claims from Mikus, which concerns a heat injector for providing heat at relatively

low heat flux (e.g., 375 watts/ foot) to subterran an formations. As stated in the affidavit by Dr. Mikus, endothermic chemical processes typically require an order of magnitude higher heat flux (e.g., 3500 to 7000 watts/foot). Therefore, it was not at all predictable from his earlier work that a heater based on flameless distributed combustion could be used for to provide the necessary heat flux to an endothermic chemical process.

The Examiner apparently recognizes that if one simply attempted to substitute the heat injector of Mikus into the endothermic reaction apparatus of Ruhl, it would not work because of the order of magnitude greater heat flux required for chemical processes. However, the Examiner relies on the statement in Ruhl that "The number of tubes in a single reactor could be as few as one to as many as 10,000 or more" to speculate that you could make the heat injector of Mikus work in the endothermic reaction apparatus of Ruhl if you simply used a whole lot more of them. Applicant submits that this is an incorrect interpretation of the teachings of the Ruhl. Ruhl's disclosure of using one to 10,000 or more combustion tubes clearly refers to the type of <u>high heat flux</u> tubes employed by Ruhl, several of which have high temperature flames (see, for example, Figs. 1 and 5). Ruhl does not support the position that a plurality of <u>low heat flux</u> heat injectors of the type disclosed in Mikus would provide sufficient heat to drive an endothermic chemical reaction. The relatively low heat flux heat injector disclosed in Mikus, while very effective for heating subterranean formations, would not be effective in the endothermic reaction apparatus of Ruhl because of

the different heat flux r quirements, whether one heat injector was used, or a hundred, or a thousand.

The Examiner is respectfully requested not to ignore the affidavit of Dr. Mikus, who is both the inventor on the Mikus reference and a co-inventor on the present application, and as such is presumed to have more than ordinary skill in the art. Dr. Mikus has clearly stated that because of the significantly higher heat flux requirements of chemical processes, it was not at all predictable that flameless distributed combustion heater could be used for this purpose. To ignore this statement and to speculate that all that is necessary to overcome the order of magnitude difference in heat flux requirements is to use more heat injectors, is a gross oversimplification of the problem and an injustice to the present invention.

Favorable action on the application in light of the foregoing amendments and remarks is respectively requested.

The Examiner is advised that a patent was granted on Applicant's counterpart European patent application. The relevant patent number is EP 1 021 682 B1.

Respectfully submitted,

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By: ______________________

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MARKED-UP COPY OF AMENDED CLAIMS

1. (Three times amended) A process heater for high temperature reactions comprising:

an oxidation chamber, the oxidation chamber having an inlet for an oxidant, an outlet for combustion products, and a flow path between the inlet and the outlet;

a fuel conduit for transporting a fuel to the oxidation chamber, the fuel conduit containing a plurality of fuel nozzles along substantially the entire length of the oxidation chamber, each nozzle providing fluid communication from within the fuel conduit to the oxidation chamber, the fuel nozzles being spaced so that fuel is added to the oxidation chamber at a rate that no flame results when the fuel is mixed with the oxidant flowing through the flow path in the oxidation chamber;

a preheater in fluid communication with the oxidation chamber inlet, the preheater capable of increasing the temperature of the oxidant to a temperature resulting in the oxidant and fuel when mixed in the oxidation chamber being hotter than the autoignition temperature of said mixture of oxidant and fuel; and

a process chamber in a heat exchange relationship with the oxidation chamber whereby a controllable heat flux is provided to the process chamber at a sufficiently high rate to complete the process being conducted therein, and the heat transferred from the oxidation chamber to the process chamber does not cause the temperature of the mixture of oxidant and fuel within the oxidation

chamber to decrease below the autoignition temperature of said mixture of oxidant and fuel in the oxidation chamber.

18. (Amended) A flameless distributed combustion process heater <u>for high temperature reactions</u> comprising:

an oxidation chamber, said oxidation chamber having an inlet for oxidant and an outlet for combustion products, and a flow path between said inlet and outlet;

a fuel conduit for transporting fuel into said oxidation chamber, said fuel conduit containing a plurality of fuel nozzles distributed along <u>substantially</u> the <u>entire</u> length of said oxidation chamber, said fuel nozzles being spaced so that the flow of fuel through said fuel nozzles results in no flame when the fuel passes through the nozzles and is mixed with oxidant flowing through said flow path in said oxidation chamber;

a preheater in fluid communication with said oxidation chamber, for preheating said oxidant to above a temperature at which when said oxidant and fuel are mixed in said oxidation chamber, the temperature of said mixture of oxidant and fuel exceeds the autoignition temperature of said mixture; and

a process chamber in heat exchange relationship with said oxidation

chamber, said plurality of nozzles distributed along <u>substantially</u> the <u>entire</u> length of said oxidation chamber being sized to provide the desired temperature distribution within said process chamber <u>and the heat flux necessary to complete the process being conducted th rein</u>.